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United States Department of Agriculture
Agricultural Research Service

Report
of
ANNUAL CORN UTILIZATION CONFERENCE

Northern Utilization Research and Development Division
and
Corn Industries Research Foundation
Technical Committee

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FOREWORD

The annual corn utilization conference was held on June 14, 1960, at the Northern Regional Laboratory. In attendance were members of the Corn Industries Research Foundation Technical Committee and staff members from the various laboratories of the Northern Utilization Research and Development Division. Opportunity was given to hear reports of research in progress at the Northern Division; to exchange ideas; and to suggest areas where research is needed.

SUMMARY

Dr. F. R. Senti outlined the recent division of the Cereal Crops Laboratory into Cereal Products and Cereal Properties Laboratories under the direction of C. E. Rist and R. J. Dimler, respectively and the scope of research underway in these and other laboratories of the Division. Research in progress under grants from Public Law 480 funds in Israel, Scotland, England, Finland, and Spain were briefly described.

Wet-milling studies on three lots of high-amylose corn containing starch of 49, 57, and 67 percent apparent amylose have shown differences in milling quality which appear to be under genetic control. The previously observed tendency for higher amylose levels to be associated with poorer recovery of starch and higher protein in the starch was offset by one sample of 67 percent amylose corn which gave starch in yield and quality approaching that of ordinary dent corn.

Starches from a series of high-amylose corn samples, ranging from 50 to 71 percent in apparent amylose as determined by iodine affinity were fractionated and characterized. The amylose fractions were not different from dent corn amylose. The amylopectin fractions, however, showed increased branch length as indicated by a higher iodine affinity, higher β -amylase conversion, and lower molecular weight with increase in amylose in the starch. A new and simplified procedure for fractionating high-amylose starch was developed on the basis of a freezing pretreatment of the starch.

The use of concentrated guanidine and/or lithium salts in conjunction with periodate oxidation offers promise for determining the true molecular weight of an amylopectin.

Casein and soybean protein were irreversibly ~~insolubilized~~ by treatment with borax-solubilized dialdehyde starch yielding products having distinctive properties.

Wet-end addition of dialdehyde starch in paper to give a retention of 0.3 to 1.0 percent of dry sheet weight was successfully accomplished by use of cationic starch in amounts ranging from 0.5 to 5.0 percent of dry fiber weight. Excellent wet-strength was attained without high temperatures or extended curing times and broke was easily repulped.

Yields of erythrose as high as 80 percent and glyoxal as high as 85 percent have been obtained from hydrolyzates of dialdehyde starch by autoclaving with water containing a large excess of SO_2 .

A large series of phosphomannans prepared by microbial synthesis has been described, all of which contain mannose and mannose-6-phosphate as the sole carbohydrate residues. Degree of phosphorylation varies from one phosphate for every other mannose unit to one for every 30 mannose units; mannose-6-phosphate units are all cross-linked through pyrophosphate bonds.

Production of an extracellular polysaccharide produced by Xanthomonas campestris NRRL B-1459 was described. Efficiency of conversion of glucose to polymer varied from over 95 percent to 30 percent as concentration of glucose in the medium was raised from 1 percent to 5 percent.

Polysaccharide B-1459 is a macromolecular polyelectrolyte constituted of glucose, mannose, glucuronic acid (as the potassium salt), and acetyl in the molar proportions of 3:3:2:2. It dissolves completely in water to yield high-viscosity solutions which are atypically stable to salt and heat.

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Service

Program

ANNUAL CORN UTILIZATION CONFERENCE

Northern Utilization Research and Development Division
and
Corn Industries Research Foundation
Technical Committee

Peoria, Illinois
June 14, 1960

Morning Session

F. R. Senti, Chairman

- 9:30 a.m. Introduction F. R. Senti
- 10:00 a.m. Wet Milling of High-Amylose Corn R. A. Anderson
- 10:30 a.m. Studies on the Fractionation of
High-Amylose Starch. E. M. Montgomery
- 11:00 a.m. Intermission
- 11:10 a.m. Evidence on Amylopectin Molecular Weight and
State of Aggregation S. R. Erlander
- 11:40 a.m. Irreversible Insolubilization of Casein and
Soybean Protein with Dialdehyde Starch F. B. Weakley
- 12:30 p.m. Luncheon

Afternoon Session

C. E. Rist, Chairman

- 2:00 p.m. Cationic Starch-Dialdehyde Starch Combinations
for Wet-Strength Paper B. T. Hofreiter
- 2:30 p.m. Separation of Erythrose and Glyoxal from
Dialdehyde Starch Hydrolyzates J. W. Van Cleve
- 3:00 p.m. Intermission
- 3:15 p.m. Microbial Polysaccharides
1. Phosphomannans M. E. Slodki
 2. Polysaccharide B-1459, Laboratory (R. F. Anderson
and Pilot-Plant Preparation. (S. P. Rogovin
 3. Polysaccharide B-1459,
Composition and Properties A. R. Jeanes

INTRODUCTION

F. R. Senti

After introducing visitors and staff members of the Northern Division in attendance, Dr. Senti outlined the research program of the Division. The former Cereal Crops Laboratory has been divided into two Laboratories--Cereal Products Laboratory under Mr. C. E. Rist with three investigation groups, Starch Products, Nonstarch Products, and Products Applications; and the Cereal Properties Laboratory under Dr. R. J. Dimler, also with three investigation groups; Chemical Reactions and Structure, Physical-Chemical Properties, and Cereal Microscopy and Quality Investigations.

No budget increases were obtained for the current year on cereals but the House and Senate have proposals for increases in FY 1961 of \$300,000 and \$500,000, respectively to be divided between the Northern and Western Divisions. The Western Division studies food and feed uses of wheat, rice, and barley, the Northern Division, processing and industrial uses and fermentations. Both Divisions do fundamental research on cereals. Our contribution to the high-amylose corn project is in supplying the analyses--15,600 samples last year, divided about equally between two corn breeders, Dr. M. S. Zuber of the Crops Research Division stationed at Columbia, Mo., and Mr. R. P. Bear of the Bear Hybrid Corn Co., Decatur, Ill. In addition we are doing laboratory and pilot-plant work on processing the corn for starch and laboratory work on characteristics of granules, film characteristics, and chemical modification of the starch. Other starch work includes studies on X-ray diffraction and molecular structure, graft polymers--under contract with the Stanford Research Institute, and other work described in this report in more detail by subsequent speakers.

Fermentation studies include microbial polysaccharides, microbial agents for control of the Japanese beetle, and toxicants, repellents, and attractants for insects by fermentation of cereal grains. Products are referred to the Entomology Research Division for evaluation.

Oilseeds research includes work on linseed oil emulsion paints for outside use and flavor stability studies on soybean oil.

The new crops screening program is seeking to find new oilseeds with unusual fatty-acid components, protein, fiber, and polysaccharides other than starch.

Grants of funds available under Public Law 480 for research on cereals have been made as follows:

Israel--Mild oxidation of starch.

Institute for Fibres and Forest Products Research.

Amino acid branched polymers from cereal grain proteins.
Weizmann Institute of Science.

Scotland--Polymerization of glucose.

Arthur D. Little Research Institute. Inveresk.

England--Structure of starch by interaction with enzymes.
University of Birmingham.

Fermentation projects of interest include:

Finland--Phosphorus compounds of yeast.
Biochemical Institute. Helsinki.

Spain--Collection and characterization of yeasts in Spain.
National Institute of Agronomic Investigations. Madrid.

Projects under negotiation covering broad areas of cereal chemistry number
21 in 7 countries.

WET MILLING OF HIGH-AMYLOSE CORN

Roy A. Anderson

High-amylose corns with starch containing up to 67 percent amylose were wet-milled on a laboratory and pilot-plant scale to gather processing information which may aid in the genetic development of this new corn. Such information is valuable to the plant breeders in planning their work for improving milling characteristics, and to the industry in providing some insight into the handling of this corn.

Processing characteristics of three high-amylose corn hybrids were compared with those of an ordinary dent corn. Corn samples containing starch with 49, 57, and 67 percent amylose contents, as well as the ordinary corn, were wet-milled according to a standard procedure, and the yields and composition of the various fractions compared. The results of the work pointed out two major differences in the processing of high-amylose corn and ordinary corn. Most significant was the decrease in the purity and recovery of starch. From ordinary corn, about 87 percent of the starch present was recovered, containing 0.51 percent protein. The recovery of starch from the 49 percent amylose corn was 80.0 percent, and from the 57 percent material only 71.4 percent. The protein content of the two starches were 0.53 and 0.70 percent, respectively. It appeared that as the amylose content of the corn was being increased, the wet-milling characteristics of the corn became poorer. However, the processing of the 67 percent amylose corn resulted in an 82.7 percent recovery of starch, containing only 0.48 percent protein. This recovery is over 10 percent greater than that obtained from the 57 percent material, and comes within 4.5 percent of the starch recovery from ordinary corn. A survey into the background of the new material revealed that the "pedigree" of the 67 percent amylose corn had been changed to introduce more favorable processing characteristics into the corn.

The pedigree change also affected the other significant difference noted in the processing of these corns. An unusually large swelling of the corn kernels was observed during the steeping of the 49 percent amylose corn, and this was even more pronounced during steeping of the 57 percent material. The kernels from the 49 percent corn exhibited an increase of 100 percent; and the 57 percent corn, 128 percent of their original dry volume as compared with a 63 percent increase in volume observed during steeping of ordinary corn. From the pattern noted in the milling of the 49 and 57 percent amylose corns, it was expected that the volume of steeped kernels from the 67 percent material would be greater, but the actual increase in the volume of these kernels was 23 percent less than that of kernels from 57 percent amylose corn.

While the overall processing results obtained with 67 percent amylose corn were not quite as good as those obtained with ordinary dent corn, processing quality was reasonably good and improvements shown over the milling of 49 percent, 57 percent, and other high-amylose corns were significant.

Comments

In response to a question it was stated that various grades or fractions of starch from wet-milling studies on high-amylose corn showed no differences in amylose content of starch fractions from a given sample. Air classification was mentioned briefly and it was remarked that no shift in amylose content has been found in high-amylose starch which was finely ground and air-classified. Reports in the literature on dent corn starch indicate that large and small starch granules from a given sample have the same amylose level.

HIGH-AMYLOSE CORN STARCH FRACTIONS

Edna M. Montgomery

Progress in the genetic development of high-amylose corn starch as a source of new industrial starches has led to an expanding program of research on high-amylose corn starch.

The primary objective of this work was to obtain fundamental information about the new starches and their linear and branched components, including a comparison with dent corn starch and its fractions. An important part of the comparison is the discovery of trends in properties of the starches and components as the amylose content of the starch progressively increases.

The report covers studies in progress on starches having six levels of "apparent amylose" content as determined by iodine affinity, ranging from 50 to 71 percent, in addition to dent corn starch. Starches included 37° C. water-steeped and 50-60° C. aqueous sulfur dioxide-steeped preparations.

Corn starch, as the amylose content of the granule increases, shows decreasing ability to swell in hot water. In the "high amylose" range, where the "apparent amylose" content of the starch is 50 percent or higher, the gelatinization temperature has increased whereas the dispersibility of the starch has become negligible. In general, 37° C. water-steeped starches are more dispersible in water than 50-60° C. sulfur dioxide-steeped starches. All starches decreased in dispersibility during prolonged storage.

High-amylose corn starches were first fractionated by a modification of the Montgomery and Senti pretreatment-extraction procedure for dent corn starch. Amylose was characterized through the crystalline N-butanol-amylose complex. Amylopectin was noncomplex forming with N-butanol and/or Pentasol. Amylose was isolated in yields accounting roughly for 80 percent of the iodine affinity of the parent starch; amylopectin took care of the remaining 20 percent.

The amyloses from high-amylose corn starch had at least as high iodine affinity, indicative of purity and molecular linearity, as amylose from dent corn starch. Molecular weight determinations by light scattering and viscometric measurements showed no significant differences between amylose from dent corn and presently available high-amylose corn starches.

Major differences in the structure of the amylopectin component were found to accompany increase in the amylose content of the corn starch granule. As a result the linear branch length of the amylopectin increased as shown by a new iodine affinity of 88 mg. I_2 /g. for 71 percent "amylose" corn amylopectin as compared to 10 mg. I_2 /g. for the dent corn fraction and by a high β -amylase conversion percentage of 75 as compared to 56 for the dent corn component. Molecular weight of amylopectin appeared to decrease sharply as the amylose content of the granule increased.

A new and simplified fractionation procedure for high-amylose corn starches by pretreatment-extraction has been discovered. This method merits consideration for fractionation of these unusual starches on a

larger scale than ordinary laboratory operation. Experimentation showed that high-amylose corn starches, hydrated at 25° in an excess of water, frozen, thawed, and isolated gelatinize uniformly at 93-94° in water, swelling simultaneously to from six to nine times in size. The thawed starch, air-dried at 25°, showed greatly increased solubility in an organic solvent, dimethyl sulfoxide. In fractionating the starch, amylose is extracted from the pretreated starch in boiling water; the amylopectin, which retains the granular outline, is removed by centrifugation, leaving the amylose in the supernatant. To date amylose has been extracted from 2 and 4 percent starch suspensions.

Comments

Amylopectin component is important to granule structure; freezing wet starch loosens the granule structure, lowers the gelatinization temperature of high-amylose starches and facilitates selective leaching of the amylose component.

EVIDENCE ON AMYLOPECTIN MOLECULAR WEIGHT AND STATE OF AGGREGATION

S. R. Erlander

The molecular weight of dent corn amylopectin or any other amylopectin is not known at this time. However, a certain amount of progress has been made in obtaining the true molecular weight of various amylopectins. At present the true weight-average molecular weight of dent corn amylopectin appears to be around 5 to 10 million.

It is postulated that amylopectin is aggregated in the granule or in solution by means of intertwining of the exterior chains of neighboring amylopectin molecules into double helices, there being three or four glucose units per helical turn. By using hydrogen-bond breaking solvents such as concentrated guanidine salts, swelling solvents such as concentrated lithium salts, or chemically altering the glucose units, or combining any of these, one might expect the amylopectin to disaggregate. Such treatments were applied, therefore, to amylopectin after control studies were made on amylose, since the molecular weight of amylose has been established with reasonable certainty.

If amylose is oxidized with periodate in water, it will both aggregate and hydrolyze. By keeping the pH around 3, alkali and acid hydrolysis is reduced to a minimum. In plotting the reciprocal of the weight-average degree of polymerization versus time and extrapolating to zero time, it was observed that the molecular weight calculated from the extrapolated value from oxidized amylose was the same as the molecular weight determined directly on amylose (initial molecular weight). Also a straight line is obtained if hydrogen-bond breaking salts are present indicating that hydrolysis of the oxidized amylose is random. However, it was observed from both sedimentation patterns and light scattering that if these hydrogen bond-breaking solvents are absent, then periodate-oxidized amylose aggregates in water. If dialyzed against 6 M guanidine hydrochloride, then these aggregates are destroyed indicating that the forces are physical and not chemical.

While for amylose the extrapolated molecular weight obtained by acid hydrolysis or by periodate oxidation followed by the spontaneous breakdown of the oxidized units is equal to the initial molecular weight for amylose, the extrapolated molecular weight of amylopectin or glycogen was generally less, being $1/3$ and $1/6$ the initial value for sweet corn glycogen and dent corn amylopectin, respectively. Hydrolysis also appears to destroy aggregates in sweet corn glycogen and sweet corn amylopectin and mature waxy amylopectin but not in dent corn amylopectin. This may be due to the fact that shorter external chains are present in the glycogen and waxy amylopectin. On the other hand, periodate oxidation appears to destroy aggregates. Oxidized amylopectin does aggregate in water with time as indicated by a concave downward curvature of the reciprocal of weight-average degree of polymerization versus time plot and a loss of material during sedimentation. If concentrated guanidine salts are used as solvents, then as in the case of amylose this aggregation is absent. The reduction in molecular weight of 43 million to 6.8 million was the

same for 20, 40, 60, or 80 percent oxidation. Consequently, the zero time value of 6.8 million appears to be a basic molecular weight. Further studies have shown that a combination of guanidine salts and periodate oxidation is necessary to destroy the original aggregation (intertwining double helices). However, in one case a dent corn amylopectin ($\bar{M}_w = 168$ million) after standing 9 months in water plus HgI_2 was not reduced in size when treated with periodate in 6 M guanidine sulfate. Also in another preparation of dent corn amylopectin, the molecular weight reduced from 160 to 5.7 million after standing 9 months in water plus HgI_2 . This also was not reduced in size when treated with periodate and thus may be similar to the basic molecular weight obtained above. The inability of the periodate and guanidine to reduce the size of the first sample may be due to an increase in crystallization or intertwining of the aggregates over the 9-month period.

From these results it is evident that further studies will be required. However, periodate oxidation in hydrogen bond-breaking solvents such as guanidine or lithium salts may be a method for determining the true molecular weight of an amylopectin.

IRREVERSIBLE INSOLUBILIZATION OF CASEIN AND SOYBEAN PROTEIN
WITH DIALDEHYDE STARCH

F. B. Weakley

The commercial importance of formaldehyde and low molecular weight dialdehydes in insolubilizing proteins in paper sizing and leather tanning has stimulated interest in insolubilizing a number of proteins with dialdehyde starch.

Borax-solubilized dialdehyde starch (95 percent periodate-oxidized) was found to react with casein and with soybean "alpha" protein at 25° C. under neutral or slightly alkaline conditions. Nearly quantitative precipitation of the reaction product was obtained at pH 3.5-4.0. The isolated product could not be redissolved in dilute alkali and was only slightly soluble in strongly acid solutions. Such properties are significant from the standpoint of usefulness in paper coating applications.

The effect of such factors as concentration of reactants and reagents, pH, and time on the course of the reaction were discussed.

CATIONIC STARCH-DIALDEHYDE STARCH COMBINATIONS FOR WET-STRENGTH PAPER

B. T. Hofreiter

Dialdehyde starch has little or no affinity for cellulose fibers. The successful utilization of dialdehyde starch as a wet-strength agent in papermaking through wet-end addition is dependent upon its efficient incorporation into the formed sheets. Studies of several "retention aids," materials used to bring about the adsorption of dialdehyde starch onto the pulp fibers, have shown that cationic starches are well suited for this purpose.

Methods and results were reported on studies of handsheets and machine-made paper incorporating dialdehyde starch as a wet-strength agent. Wet strengths with dialdehyde starch were equal to or better than commercial papers made with urea-formaldehyde and melamine resins. The effects of time and temperature used in making the dialdehyde starch dispersion, different levels of dialdehyde starch in combination with alum and commercial cationic starch, time of contact of dialdehyde starch and retention aids with the pulp, pH of furnish, and temperature were described. Further studies of these and other variables are indicated.

Optimum conditions for the most effective application (in handsheets) may tentatively be described as follows: The addition of cationic starch dispersions is made to the pulp slurries maintained at pH 6 and a minimum contact time of 20 minutes employed. Dialdehyde starch is added next, followed by immediate acidification to pH 4.5 and sheet formation. Application of dialdehyde starch at or near the headbox is recommended for machine application.

Cationic starch used in quantities ranging from 0.5 to 5 percent (of dry fiber weight) have resulted in satisfactory retention of dialdehyde starch. Excellent wet strengths were obtained when dialdehyde starch was retained in the sheets in the range 0.3 to 1.0 percent (based on dry sheet weight).

Factors associated with the use of this system which should be favorable to any industrial application are:

1. The ease with which broke can be repulped.
2. The good stability of dialdehyde starch, both when dry and when in solution.
3. The rapid development of wet strength on drying--no high temperatures or extended curing time required.
4. The present commercial availability of dialdehyde starch.

Comments

In answer to a question on the storage stability of dialdehyde starch it was stated that the shelf life of dialdehyde starch preparations for wet-strength paper is very good. A 3-percent paste has been kept over 6 months in a refrigerator and over 1 month at room temperature without deterioration.

SEPARATION OF ERYTHROSE AND GLYOXAL FROM DIALDEHYDE STARCH HYDROLYZATES

J. W. Van Cleve

Periodate-oxidized starch ("dialdehyde starch") was first described by C. J. Hudson and E. L. Jackson in 1937 (*J. Am. Chem. Soc.* 59: 2049, 1937). Hydrolysis of this substance with mineral acid gave extensive degradation and only 20 and 30 percent yields, respectively, of the expected glyoxal and erythrose. Five years later C. B. Purves (*Paper Trade J.* 115 (7): 41, 1942) reported the cleavage of periodate-oxidized starch by methanolysis (refluxing with anhydrous methanol containing 10 percent HCl gas) to give glyoxal tetramethyl acetal in 50 percent yield and a glyoxal-erythrose composition of indefinite structure.

Recent views of the true structure of the dialdehyde units resulting from periodate oxidation of glycosides and polysaccharides indicate the presence of hydrolysis-resistant 1,4-dioxane ring systems due to internal cyclization. At this Laboratory it has been found possible to hydrolyze periodate-oxidized starch smoothly to give good yields of erythrose (80 percent) and glyoxal (85 percent) by autoclaving at 100°-115° C. with water containing a large excess of SO₂. The sulfurous acid apparently adds to the aldehyde groups in a manner analogous to bisulfite addition thus preventing internal cyclization and at the same time providing the necessary acidity for hydrolysis of the acetal linkages. Optimum results are obtained with a concentration of dialdehyde starch of about 4 percent.

By means of a novel liquid-liquid extraction technique the erythrose and glyoxal can be concentrated by transfer to *n*-amyl alcohol and re-extracted with a receiving solution of sulfurous acid. Calculations using partition coefficients indicate that aqueous solutions containing up to 20 percent glyoxal may be obtained by this means through recycling. Erythrose concentration is also increased by this procedure. Addition of acetaldehyde followed by benzene extraction removes the erythrose exclusively as an ethylidene derivative which is presumably 1,3-ethylidene-D-erythrofuranose. The latter can be readily hydrolyzed to yield erythrose and acetaldehyde.

MICROBIAL POLYSACCHARIDES

1. Phosphomannans

M. E. Slodki

The extracellular phosphorylated mannan produced from glucose by the yeast Hansenula holstii NRRL Y-2448 has been described at a previous meeting of this group. We have now uncovered nearly 30 different phosphomannans which are elaborated by related species of Hansenula and other genera.

All of the phosphomannans contain mannose and mannose-6-phosphate as the sole carbohydrate residues. The acid-stable phosphate ester can be recovered from hydrolyzates in over 95 percent yields. Polymer types range from those having nearly every other mannose residue phosphorylated to relatively lightly phosphorylated mannans. They also vary with respect to apparent degree of polymerization of mannosidic units and optical rotation. Certain of the new phosphomannans give higher solution viscosities than the Y-2448 polymer and are produced in similarly good yields.

In the phosphomannans tested the mannose-6-phosphate residues are all cross-linked through pyrophosphate bonds. Under conditions of mild acid hydrolysis these pyrophosphate linkages are split, leaving the mannosidic bonds intact. The polymannosidic phosphomonoesters thereby produced are potentially useful as dispersants.

MICROBIAL POLYSACCHARIDES

2. Polysaccharide B-1459, Laboratory and Pilot-Plant Preparation

R. F. Anderson and S. P. Rogovin

Production of the extracellular polysaccharide produced by Xanthomonas campestris NRRL B-1459 has been studied in the laboratory and in pilot-plant equipment of 20-liter, 60-gallon, and 600-gallon capacity. Best yields were obtained from a medium consisting of glucose, Stimuflav, KH_2PO_4 and MgSO_4 , at the optimum conditions of 28° C., pH 7.0, and aeration of 1 mM. O_2 /lit./min. Efficiency of conversion of glucose to polymers in shaker flasks in a 120-hour fermentation varied from over 95 percent at 1 percent glucose level to only about 30 percent when 5 percent glucose was used. High viscosity of the polymer in culture liquors prevented adequate aeration in shaker flasks and the maximum utilization of glucose by the organism was ca. 2.5 percent even though the fermentations were incubated for 8 days. Additions of glucose in increments did not increase either the polysaccharide yield or sugar utilization. Pilot-plant fermentations at an initial glucose concentration of 3 percent were complete in 96 hours. Yield of recovered polymer was about 50 percent on glucose.

MICROBIAL POLYSACCHARIDES

3. Polysaccharide B-1459, Composition and Properties

A. R. Jeanes

Polysaccharide B-1459 is a macromolecular polyelectrolyte constituted of glucose, mannose, glucuronic acid (as the potassium salt), and acetyl in the molar proportions of 3:3:2:2. The sugar units appear to be linked through 1→2 glycosidic bonds in β -configuration. The polysaccharide dissolves easily and completely in water to give solutions having viscosities comparable with those of guar and high viscosity alginates. These solutions show short flow properties and the rheological behavior of a plastic fluid.

Atypically of polyelectrolytes, increased viscosities are obtained by adding salt to aqueous solutions having concentrations greater than about 0.3 percent or by dissolving the polysaccharide in salt solutions such as 5 percent potassium chloride. Viscosities of solutions in the presence of salts are atypically stable to heat. These unusual properties appear to be due to the conformation and structure which hold the molecules in a distended form and prevent their collapsing into random coils even when uncharged.

Aqueous solutions can be cast to give films which compare favorably in dry tensile strength with corn amylose films and which show unusually high flexibility when plasticized with glycerol.

Thus this bacterial polysaccharide, produced from corn sugar, differs greatly from starch in composition and properties and therefore in potential uses. An additional property of practical significance is the stability of the dry solid in storage.

Comments

A question was asked on comparison of our microbial polysaccharides with other polysaccharides. While similar in certain respects to guar and alginates, the microbial polysaccharides have unique properties of salt and heat insensitivity. Feeding trials over 90 days on rats at the Western Division showed no digestibility and no apparent toxicity. β -configuration instead of α may be significant in the unique properties of B-1459 films.

GENERAL DISCUSSION

Dr. Senti asked if the C.I.R.F. representative had any comments or suggestions for our program. Dr. Goodwin said that these subcommittees of the C.I.R.F. were meeting on the next day and he would let us know if anything of interest to this Division developed.

Dr. Senti also asked if the B.O.D. problem created by the use of starch in textile plants warranted research by us. The use of starch in textiles is being threatened by other coating agents which have a lower B.O.D. even though they are more expensive. It might be better to attempt to change the properties of starch so as to decrease the B.O.D., even at an increased cost, than to lose the market and be forced to find new markets. The comment was made that starch accounted for only half of the B.O.D. of textile plant wastes. A simple means for destroying the starch before it reached the stream would improve the pollution problem. Dr. J. W. Evans mentioned they were working on this problem of B.O.D.

Dr. Powell commented that since the starch industry was selling starch granules, he felt that starch granule properties were relatively more important than the molecular properties of the separated components. Dr. Senti replied that the granule properties must ultimately depend on the properties of the amylose and amylopectin and that in highly swollen starch pastes essentially free molecules must be present. Moreover, information on starch granule structure is being gained in our studies on starch fractionation employing pretreatments, such as by organic solvent or freezing, which show that the coherent structure of the swollen starch granule must result largely from bonding between amylopectin molecules.

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Service

ANNUAL CORN UTILIZATION CONFERENCE

Northern Utilization Research and Development Division
and
Corn Industries Research Foundation
Technical Committee

Peoria, Illinois
June 14, 1960

List of Attendance

CORN INDUSTRIES RESEARCH FOUNDATION TECHNICAL COMMITTEE

Corn Industries Research Foundation, Inc., Washington, D. C.

J. Goodwin, Technical Director

American Maize-Products Company, Roby, Indiana

J. W. Evans, Director of Research
E. L. Powell, Assistant Director of Research

Anheuser-Busch, Inc., St. Louis, Missouri

A. J. DeGrand, Jr., Manager, Corn Products
B. L. Scallet, Associate Director, Central Research Dept.

Clinton Corn Processing Company, Clinton, Iowa

G. T. Peckham, Jr., Research Director
A. D. Campbell, Assistant Research Director

Corn Products Company, Argo, Illinois

H. Gehman, Assistant Director of Research
A. L. Wilson, Assistant Director of Research
R. J. Smith, Chemist

National Starch and Chem., Plainfield, New Jersey

C. G. Caldwell, Vice President - Research
O. B. Wurzburg, Associate Director of Research

Penick and Ford, Ltd., Cedar Rapids, Iowa

W. C. Black, Research Chemist
K. W. Kirby

A. E. Staley Company, Decatur, Illinois

T. L. Gresham, Vice President
V. A. Bralley, Director of Chemical Research

Union Starch and Refining Company, Granite City, Illinois

R. E. Pyle, Research Director
V. F. Lenney, Research Chemist

NORTHERN UTILIZATION RESEARCH AND DEVELOPMENT DIVISION

F. R. Senti, Director
W. C. Witham, Assistant Director
L. L. McKinney, Assistant Director
J. E. Hubbard, Assistant to Director

W. K. Trotter, Marketing Specialist
K. R. Majors, Extension Specialist
D. M. Mayberry, Information Specialist

Cereal Products Laboratory

C. E. Rist, Chief
A. J. Ernst
L. A. Gugliemelli
G. E. Hamerstrand
B. T. Hofreiter
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